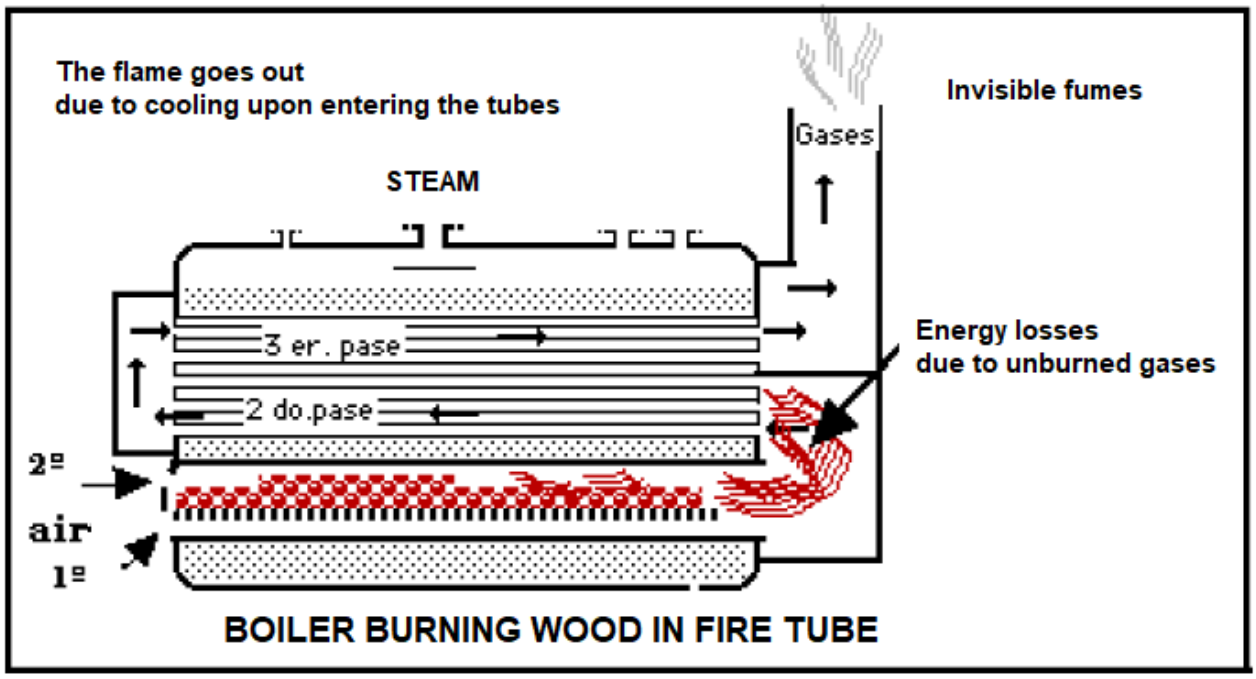
CHAPTER 5: Operation Part 3

LET'S SEE HOW WOOD-FIRED BOILERS ARE OPERATED



START-UP OF WOOD-FIRED BOILERS

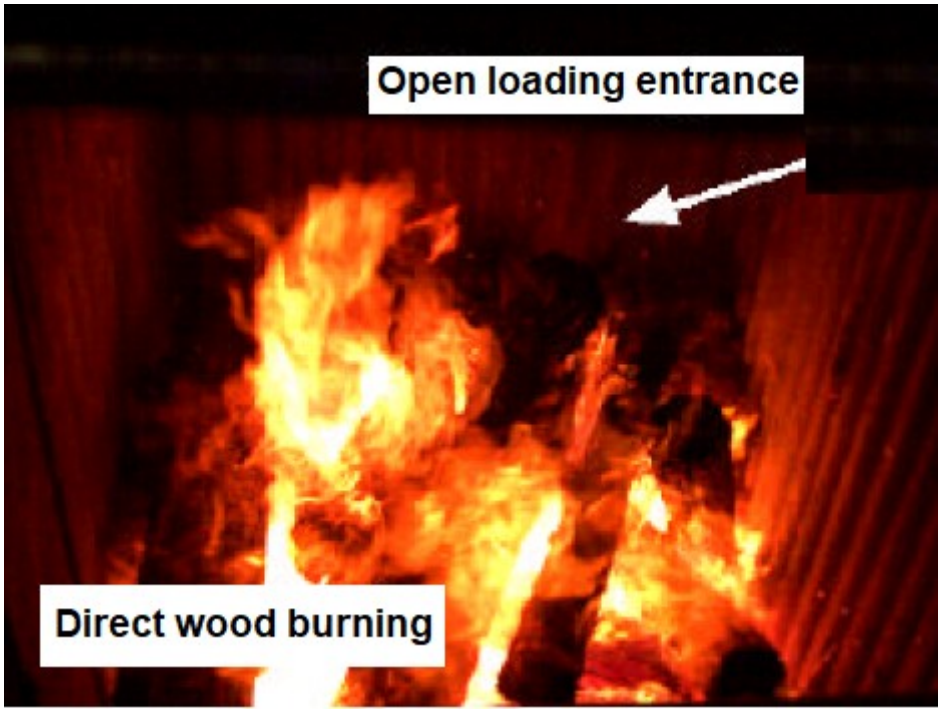
Wood is an excellent fuel. Its carbon and hydrogen content gives it a good calorific value, although it already contains a significant amount of oxygen, which we assume is already bonded to the hydrogen (therefore, wood combustion is similar in its gas emissions to coal combustion, producing a high CO2 content on a dry basis, almost over 20%). The most undesirable element in wood is water or moisture, but the sulfur content is practically zero.

We must clarify that the firewood we normally use in boilers is eucalyptus wood and not forest firewood, which, although it is a national heritage that should not be consumed, not only for this reason, but because in its combustion it produces an ash that melts like glass, which clogs the grates or grills, affecting the operation of the boiler; this does not happen with eucaliptus wood.

Although firewood produces a high CO2 content in its smoke, it has the advantage that this CO2 is consumed by the tree itself during its growth or wood formation. In other words, a balance is created between the CO2 produced and the CO2 consumed, which means that it does not accumulate in the atmosphere, as happens with

fossil fuels (coal, oil, and other natural liquids and gases extracted from petroleum).

We must divide into two cases: **1- direct burning boilers** and **2- gas generator burning.**



When starting up a boiler, the first step is to check all the components involved in its operation:

1- Verify that it is filled with suitable water (softened, chemically treated, etc.) to almost the normal level (1/4 of the visible level or the pump's automatic cutoff, as the level will rise as the water temperature increases).

To fill the boiler, close all the drain valves and open the atmospheric valve (air vent). It is assumed that the main steam valve (throat valve) is closed.

If the boiler is in a dry storage condition, first remove the drying agents from inside (quicklime, silica gel, etc.), install access panels, and perform a leak test (hydraulic).

If it is flooded with treated water for a wet storage condition, it is generally sufficient to lower the water level using the drain valves, opening the atmospheric valve to break the vacuum (to allow air to

enter).

2- Check the level controls (open their purges and verify that the feed pump is activated, before opening their suction and discharge valves; listen and look for signs of low level). In some cases, it is necessary to perform a **hydraulic "leak test"** (test for water or steam leaks).

To do this, you can slowly build up the "working" pressure using the same wáter **feed pump**, venting the air through the **atmospheric valve** (the atmospheric valve serves both to vent air and gases and to prevent a "vacuum" from forming inside the boiler when cooling or emptying it).

After 10 minutes of pressure (with all valves closed), observe the exterior and interior of the boiler (firebox and smoke boxes) for **water leaks**, and ensure that the pressure on the gauge does not drop more than very slowly (this indicates a leak in the packing). Then, slowly lower the pressure (purge) and regulate the level (purge and atmospheric valve). Finally, proceed to start the boiler.

Remember that **combustion will be handled by the air that enters the home**, below the "grill" (primary air) and above the "grill" (secondary air) and that they will depend on the **opening of the registers** and the **depression of the home** ("vacuum" caused by the natural draft of the chimney or by an **induced draft fan**).

Since the wood load is normally stable (a certain height above the grate), **to increase combustion we must increase the air below the wood,** so that combustion occurs whose heat volatilizes some of the wood.

This "wood gas" combusts with the "excess air" that entered below the grate, **establishing a bright, high-temperature flame.**

What allows for rapid combustion of the gas is the air already heated in the **primary combustion zone** and the **air that enters above the grate, the secondary air**.

Many of these boilers **preheat the air that enters under the "grate"** by taking advantage of the heat from the flue gases (lowering their temperature to less than 160ºC 320°F), in order to **increase the efficiency of the boiler** (making better use of the heat) and improving combustion conditions (at a higher temperature, combustion is "faster" and wood with a high moisture content, more than 40% moisture, can be burned).

This preheating is possible because the grates are "cooled" (the grates that make up the grate are made of a special alloy cast iron). When mounted on tubes through which the boiler water circulates, this allows the metal of the grate to be "cooled" (preventing its temperature from becoming too high), while simultaneously preheating the air and the grates (whose temperature will be at least close to the temperature of the boiler water).

The air can then be "preheated" without the risk of "burning" the grates at temperatures exceeding 150°C (302°F). (This increases the combustion reaction rate, ensuring that combustion occurs before the air leaves the combustion chamber).

The fact that the primary air is preheated (with or without an air preheater) means that this air plays a fundamental role in complete combustion, with secondary air being used only at high vaporization rates.

The combustion of carbon and hydrogen occurs in different stages. Even the low moisture content of the wood is favorable to this combustion, as it interacts with the carbon at high temperatures and causes gasification in the combustion chamber, which promotes flame formation (a luminous flame is very effective for heat transfer by radiation).

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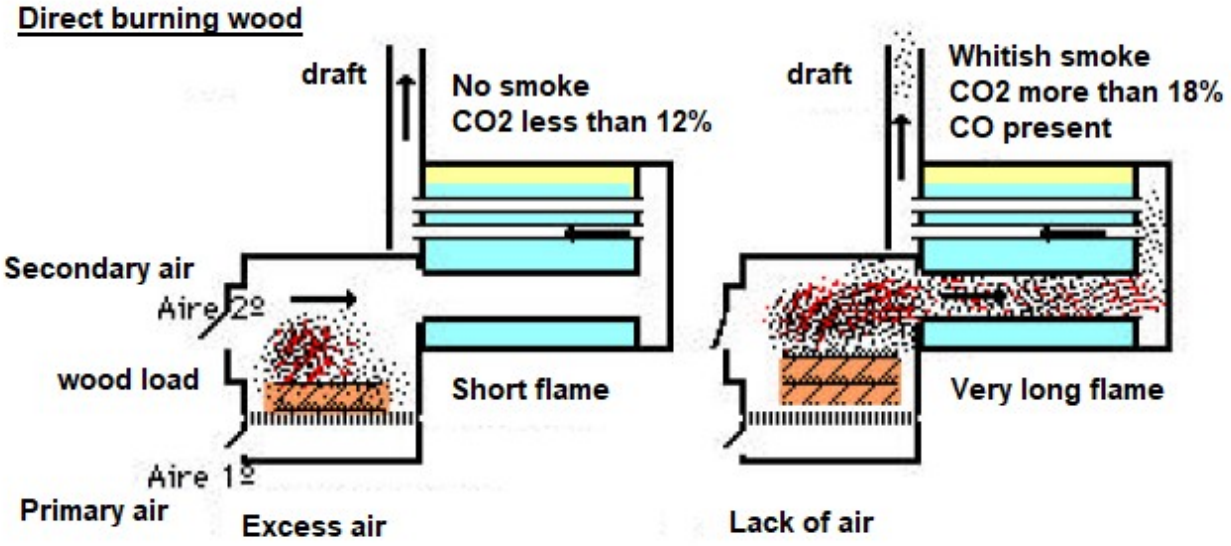


Start-up:

It is important to properly purge the firebox with air (by opening the induced draft and dampers 1 and 2) and **never use liquid fuels that can gasify (be careful, if the grill is hot: diesel, oils, or even fuel oil can gasify).**

Always maintain negative pressure in the firebox and a small purge. Whenever working with the firebox open, you must maintain negative pressure: **never open the firebox with the damper closed and/or the induced draft turned off**.

The air entering through the loading port may cause the gases inside the firebox to ignite (since there has been no purging of the flue). **This can happen while adding dry or dampened combustible materials (such as cardboard, tow, husks, paper, kindling, etc.) if the fire is not yet hot.**

Use a cotton swab to light the base of these materials and gradually add more wood (thin logs, slabs, etc.) until you can add logs of sufficient size.

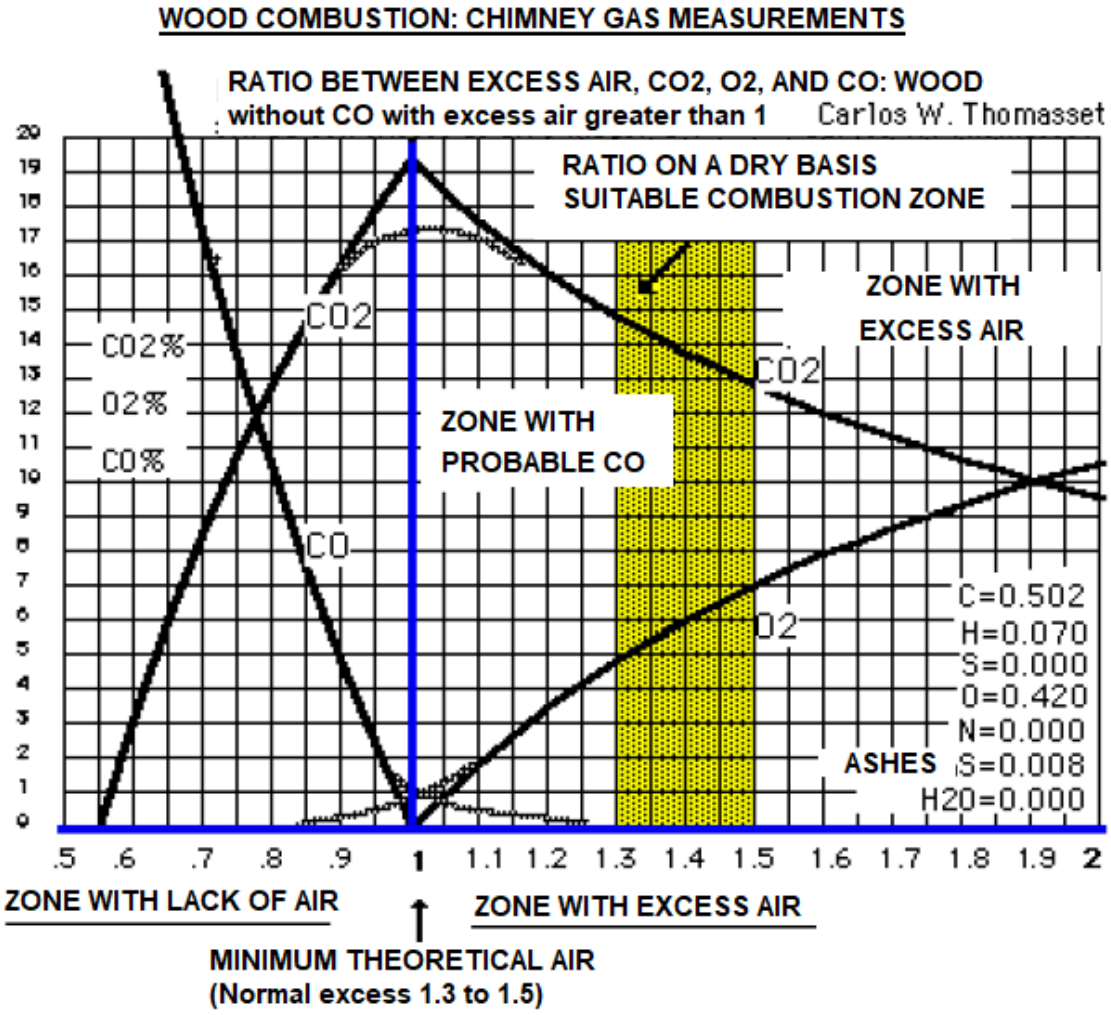
Do not build a large fire with a cold boiler; heat the entire boiler gently and evenly.

Initially, work the fire with "excess air" (by keeping the damper open and supplying air through dampers 1 and 2, as combustion will be inefficient in the cold firebox).

A cold boiler should be warmed up over several hours (2 to 8 hours, depending on the boiler), and if the boiler has been off since the previous day, a couple of hours will suffice (1 to 2 hours, depending on the type of boiler).

We reiterate: do not introduce liquid fuels by "pouring" them through the loading hatch, as this can cause a combustion explosion (when they vaporize and mix with the air inside the combustion chamber, they form an explosive mixture).

Never open the loading hatch with the draft closed (natural or induced) or the induced draft fan turned off (when there is insufficient natural draft).


WOOD COMBUSTION: CHIMNEY GAS MEASUREMENTS
RATIO BETWEEN EXCESS AIR, CO2, O2, AND CO: WOOD
without CO with excess air greater than 1
Carlos W. Thomasset
RATIO ON A DRY BASIS
SUITABLE COMBUSTION ZONE
ZONE WITH
EXCESS AIR
CO2
CO2%
O2%
CO%
ZONE WITH
PROBABLE CO
CO
O2
C=0.502
H=0.070
S=0.000
O=0.420
N=0.000
ASHES S=0.008
H20=0.000
20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1 0
.5 .6 .7 .8 .9 1 1.1 1.2 1.3 1.4 1.5 1.6 1.7 1.8 1.9 2
ZONE WITH LACK OF AIR
ZONE WITH EXCESS AIR
MINIMUM THEORETICAL AIR
(Normal excess 1.3 to 1.5)